(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 792 692 A1

(12) EUROPEAN PATENT APPLICATION
published in accordance with Art. 158(3) EPC

(43) Date of publication:
03.09.1997 Bulletin 1997/36

(21) Application number: 96932814.5

(22) Date of filing: 02.10.1996

(51) Int. Cl.[6]: B05B 1/00

(86) International application number:
PCT/JP96/02886

(87) International publication number:
WO 97/12684 (10.04.1997 Gazette 1997/16)

(84) Designated Contracting States:
DE FR GB IT

(30) Priority: 03.10.1995 JP 256002/95

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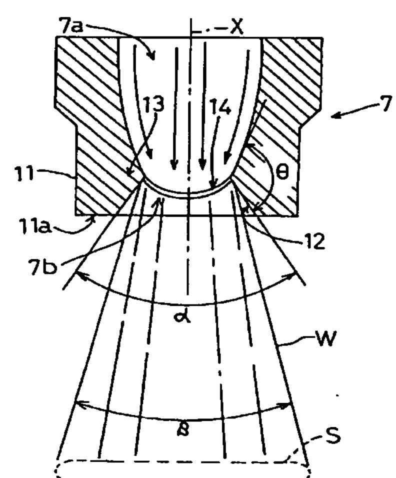
(54) SCALE REMOVING NOZZLE

(57) A scale removing nozzle for removing scales on a metal surface by causing highly pressurized liquid to impact against the metal surface. Recently, in order to improve the scale removing performance, there is a demand for jetting ultra-highly pressurized water whose pressure is in the range of 30-100MPa, but ultra-highly pressurized water like this tends to badly damage an orifice portion of the nozzle and there has been no nozzle available having sufficient durability. In the scale removing nozzle, a concave portion (12) is formed in a leading end portion (11) in a liquid injecting direction of a nozzle main body (7), the concave portion being formed such that it gets smaller in diameter toward the upstream of the liquid injecting direction, the leading end portion (11) being formed annularly and integrally with the concave portion (12) such that the leading end portion surrounds the full outer circumference of the concave portion, an outlet side of an orifice (7b) being provided such that it opens along its full circumference toward the bottom side of the concave portion (12), whereby the wear resistance of the orifice at its circumferential portion against the ultra-highly pressurized water and durability can be provided, thereby making it possible to effectively prevent early failure.

FIG. 4



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2.14.12/3.4

Description

[TECHNICAL FIELD]

The present invention relates to descaling nozzles, and particularly to a descaling nozzle having a nozzle body formed of cemented carbide and defining a liquid passage having a diameter reducing as it extends downstream with respect to a liquid jetting direction, and a orifice in the form of a slot when seen in the liquid jetting direction and having an inlet communicating with a downstream position with respect to the liquid jetting direction of the liquid passage, for causing a high-pressure liquid jetting from the orifice to collide with a metal surface to remove scales from the metal surface.

[BACKGROUND ART]

In order to enhance descaling performance, there has been a demand in recent years for the above-mentioned descaling nozzle to jet ultrahigh-pressure water with a pressure of about 30 to 100 MPa. However, the higher pressure of such ultrahigh-pressure water wears orifice peripheries of the nozzle body at the greater rate through contact with the orifice peripheries. In order to meet the demand, it is necessary to minimize the wear of the orifice peripheries, thereby to increase durability.

When the jetting high-pressure water is collected for repeated use, the high-pressure water contains fine scales ad the like. The fine scales and the like further accelerate the wear.

Under the circumstances, it has been considered to increase the hardness of the cemented carbide forming the nozzle body, thereby to improve wear resistance of orifice peripheries. For example, the nozzle body may be formed of a carbide hard metal containing tungsten (W) as its main component. However, it is known that, with increased hardness, tenacity and impact resistance are impaired to become susceptible to chipping (Japanese Laid-open Patent Application No. 4-348873).

In a conventional descaling nozzle, as shown in Figs. 12-14, a nozzle tip 01 acting as a nozzle body includes a groove 03 of U-shaped cross section formed in a distal end thereof ad crossing a high-pressure water discharge passage 02 in a downstream position with respect to a high-pressure water jetting direction. An elongated (when seen in the high-pressure water jetting direction) orifice 04 is formed at the intersection of the high-pressure water discharge passage 02 and the groove 03. Orifice peripheries 05 define thin wall portions 06 in the form of knife edges in bottoms of the groove 03 and at longitudinal positions of the orifice (Japanese Laid-open Patent Application No. 1-111464).

When ultrahigh-pressure water is jetted with a higher pressure than before, the thin wall portions 06 tend to be worn away or chipped as indicated by dot-and-dash lines in Fig. 13. The orifice peripheries 05 are damaged quickly, resulting in a deformation of the orifice 04 and a reduction in the jetting pressure of the ultrahigh-pressure water to become unable to remove scales efficiently. Thus, there is a drawback that the durability of the orifice peripheries 05 cannot be improved. Particularly where ultrahigh-pressure water containing fine scales is jetted, there occurs a drawback that the thin wall portions 06 are more susceptible to chipping due to the fine scales colliding with the thin wall portions 06.

When descaling rolled metal, a plurality of descaling nozzles are often juxtaposed for use. Ultrahigh-pressure water jetting from one descaling nozzle may splash in the longitudinal direction of the groove 03 of another descaling nozzle and collide with the thin wall portions 06 of that nozzle tip 01. This may also result in early damage of the orifice peripheries 05.

The present invention has been devised to solve these drawbacks of the prior art, and its object is to provide a descaling nozzle which includes orifice peripheries of improved configuration whereby the orifice peripheries have increased wear resistance against ultrahigh-pressure water, and which effectively prevents the orifice peripheries from being damaged due to a decrease in the impact resistance resulting from the increased wear resistance.

[DISCLOSURE OF THE INVENTION]

The above object is fulfilled by the claimed invention.

The characteristic construction of a descaling nozzle according to the present invention is as follows:

A nozzle body formed of cemented carbide defines;

a liquid passage having a diameter reducing as it extends downstream with respect to a liquid jetting direction; and
an orifice having an inlet communicating with an end of said liquid passage downstream with respect to the liquid jetting direction and elongated when seen in the liquid jetting direction;
said orifice jetting out a high-pressure liquid against a metal surface to remove scales from the metal surface;
said nozzle body including a concave section formed at a forward end thereof with respect to the liquid jetting diretion and having a diameter reducing as it extends downstream with respect to the liquid jetting direction, said forward end having an annular shape integrally surrounding an entire outer circumference of said concave section; and said orifice having an outlet opening at a bottom of said concave section through an entire circumference thereof.

In this construction, the concave section and an inner surface of the liquid passage may form a large angle across orifice peripheries through the entire circumference of the orifice. The orifice peripheries may be thick-walled in the liquid jetting direction through the

entire circumference of the orifice. Furthermore, the outlet of the orifice is entirely surrounded by the annular forward end protruding in the liquid jetting direction. There is little possibility of high-pressure water jetting from a different descaling nozzle splashing back and colliding with the outlet of the orifice. In addition, the forward end having an annular shape integrally surrounding the entire outer circumference of the concave section, provides a reinforced structure to cope with severe conditions, compared with a forward end formed by a separate element.

Consequently, the hardness of the cemented carbide forming the nozzle body may be increased to enhance wear resistance of the orifice peripheries against ultrahigh-pressure water, and at the same time the orifice peripheries may be prevented from being damaged soon due to a decrease in the impact resistance resulting from the increased hardness of the cemented carbide.

Specifically, a construction as shown in Figs. 4 and 6 can be realized.

In the descaling nozzle of the present invention, it is preferable that said cemented carbide has a Rockwell hardness (HRA) of 94.0 or higher by A Graduation of Rockwell hardness test stipulated in the Japanese Industrial Standards.

This construction can prevent, with greater effect, the orifice peripheries from being damaged soon, to realize a descaling nozzle having increased durability.

Nozzle bodies shaped according to the present invention were manufactured by using cemented carbide A, B, and C whose Rockwell hardness (HRA) was 88.7, 90.7, and 94.0, respectively. Each of these nozzle bodies was attached to a descaling noble. Each descaling nozzle was used to jet high-pressure water with a pumping pressure of 15.7 MPa for a fixed time period (about five weeks) under the same conditions, and a flow increase rate accompanying damage to the orifice peripheries was measured. As shown in Fig. 9, the descaling nozzles employing the nozzle bodies formed of cemented carbide A and B had very high flow increase rates. By contrast, the dealing nozzle with the nozzle body formed of cemented carbide C had a minimal increase rate. In addition, the flow increase rate became the lower with an increase in the Rockwell hardness (HRA) over 94.0. Thus, the orifice peripheries are prevented from being damaged with greater effect by using cemented carbide having a Rockwell hardness (HRA) of 94.0 or higher.

It is preferable that the concave section of the descaling nozzle of the present invention is formed to be out of contact with the high-pressure liquid jetting from said orifice.

With this construction, the concave section is hardly worn away or chipped. A jet pattern of the high-pressure water does not change with the shape of the concave section. Consequently, the jet pattern may be maintained in a predetermined pattern without difficulty.

It a preferable that an inner surface is formed through an inner circumference of said orifice to extend parallel to a orifice axis and between an inlet and an outlet of said orifice.

In this construction, as shown in Figs. 4 and 6, the orifice peripheries 13 can be further thick-walled in the liquid jetting direction. In addition, as shown in Fig. 5, an inlet-side corner 15 and an outlet-side corner 16 of the orifice peripheries 13 may define obtuse angles, to reinforce the orifice peripheries 13 to prevent early damage thereof with increased effect.

[BRIEF DESCRIPTION OF THE DRAWINGS]

Fig. 1 is a sectional view of a descaling nozzle device;
Fig. 2 is a perspective view of a nozzle tip;
Fig. 3 is a front view of the nozzle tip;
Fig. 4 is a section taken on line IV-IV of Fig. 3;
Fig. 5 is an enlarged view of a portion of Fig. 4;
Fig. 6 is a section taken on line VI-VI of Fig. 3;
Fig. 7 is a graph for comparing impact distributions;
Fig. 8 is a perspective view of a principal portion showing a way of measuring the impact distributions;
Fig. 9 is a graph showing a relationship between hardness of cemented carbide and flow increase rate;
Fig. 10 is a sectional view of a principal portion of a second embodiment,
Fig. 11 is a an enlarged view of a portion of Fig. 10;
Fig. 12 is a perspective view of a conventional nozzle tip;
Fig. 13 is a front view of the conventional nozzle tip; and
Fig. 14 is a section of taken on line XIV-XIV of Fig. 13.

[BEST MODE FOR CARRYING OUT THE INVENTION]

[FIRST EMBODIMENT]

Fig. 1 shows a descaling device in this embodiment.

This descaling device has a descaling nozzle 1 fixed to an adapter P2 for removing scales from a steel plate surface. As shown in Fig. 4, the descaling device removes scales from a surface of rolled steel plate by jetting high-pressure water W as high-pressure liquid with a pumping pressure of 15 to 60 Mpa, in a thin band spray pattern S to the surface of steel plate. The descaling nozzle 1 includes a cylindrical passage forming member 2, a filter 3 screwed to one end of the passage forming member 2, and a jet passage forming member 4 screwed to the other end of the passage forming member 2.

The passage forming member 2 has, formed coaxially with each other, a straightening passage 2a with a straightening device 5 mounted therein, and a restricting passage 2b continuous with a downstream end of

the straightening passage 2a. The jet passage forming member 4 has a nozzle tip 7 coaxially press-fit in a nozzle case 6 to act as a nozzle body formed of carbide hard metal containing tungsten as a main component thereof. A bush 9 is mounted between the nozzle tip 7 and the passage forming member 2, and a jet passage 8 is formed downstream of the restricting passage 2b to continuous and coaxial therewith.

The adapter P2 is attached to a main pipe P1 in the form of a branch pipe. The descaling nozzle 1 is inserted into the adapter P2 with the filter 3 protruding into the main pipe P1. A packing is disposed between a flange 6a of the nozzle case 6 and an end of the adapter P2, and the nozzle case 6 is fixed tight to the adapter P2 with a cap nut 10. Thus, the descaling nozzle 1 is fixed to the main pipe P1.

The nozzle tip 7 is formed of cemented carbide whose Rockwell hardness in A Graduation of Rockwell hardness test (HRA) stipulated by JIS Standard (Japanese Industrial Standard) is about 94.0. As shown in Fig. 2, the nozzle tip 7 has a high-pressure water discharge passage 7a defining a downstream end of the jet passage 8 and having a diameter reducing as it extends downstream with respect to a high-pressure water jetting direction, and an orifice 7b having an elongated (elliptic) shape when seen in the high-pressure water jetting direction, with an inlet thereof communicating with the end of the high-pressure water discharge passage 7a downstream with respect to the high-pressure waterjetting direction. The orifice 7b jets out high-pressure water W against the surface of steel plate, thereby removing scales from the surface of steel plate.

As shown in Figs. 3-6, the nozzle tip 7 has, formed on an end portion 11 forward with respect to the high-pressure water jetting direction, a flat surface 11a extending at tight angles to the high-pressure water jetting direction. The flat surface 11a has in its center a conical concave section 12 of elliptical shape when seen in the high-pressure water jetting direction, having a diameter reducing as it extends upstream with respect to the high-pressure water jetting direction. The end portion 11 has an annular shape integrally surrounding the entire outer circumference of the concave section 12. The orifice 7b has an outlet opening to the entire bottom of the concave section 12. Orifice peripheries 13 are thick-walled in the high-pressure water jetting direction throughout the entire circumference of the orifice 7b.

Through the inner circumference of the orifice 7b between the inlet and outlet of the orifice 7b, is formed an inner surface 14 having a small width (about 0.2mm in the embodiment) and extending parallel to orifice axis X. The concave section 12 has an opening angle (set to about 60o. The high-pressure water W jets out of the orifice 7b at a jetting angle (of about 27o to be clear of the concave section 12.

A descaling nozzle employing the nozzle tip 01 of conventional shape shown in Fig. 12 and a descaling nozzle employing the nozzle tip 7 shaped according to the present invention were manufactured to provide the same flow rate and jetting angle (. Then, impact distributions were measured with a pressure sensor Q as shown in Fig. 8, by setting pumping pressure at 14.7 MPa, 29.4 MPa, 49.0 MPa and 62.8MPa. The results are shown in Fig. 7. It is seen from Fig. 7 that there is little difference between the impact distribution obtained from the nozzle tip 01 having the conventional shape and the impact distribution obtained from the nozzle tip 7 shaped according to the present invention.

Nozzle bodies shaped according to the present invention were manufactured by using cemented carbide A, B, and C whose Rockwell hardness (HRA) was 88.7, 90.7, and 94.0, respectively. Each of these nozzle bodies was attached to a descaling nozzle. Each descaling nozzle was used to jet high-pressure water with a pumping pressure of 15.7 MPa for a fixed time period (about five weeks) under the same conditions, and a flow increase rate accompanying damage to the orifice 7b was measured. The results shown in percentage in Fig. 9 indicate that the descaling nozzles employing the nozzle bodies formed of cemented carbide A and B had very high flow increase rates. By contrast, the descaling nozzle with the nozzle body formed of cemented carbide C had a minimal increase rate.

Varied methods are available for manufacturing cemented carbide having a Rockwell hardness (HRA) of 94.0 or higher. For example, it can easily be obtained by making particles of a carbide intermetallic compound (such as WC) uniform and fine (e.g. 1(m or less in diameter) or by adding a proper amount of one or more metal carbides (or nitrides), such as titanium, tantalum, and vanadium, to the carbide intermetallic compound.

[Second Embodiment]

Figs. 10 and 11 show an embodiment including no inner surface 14 formed throughout the inner circumference of the orifice 7b to be parallel to the orifice axis X as shown in the first embodiment Other aspects are the same as in the first embodiment. This embodiment can also provide a descaling nozzle having orifice peripheries of higher durability than in the prior art.

[Other Embodiments]

(1) The concave section may be formed to become larger in diameter (like a trumpet).

(2) Inner surfaces parallel to the orifice axis may be formed at parts of the inner circumference of the orifice between the inlet and the outlet thereof.

(3) The concave section may be so formed as to contact the high-pressure liquid jetting from the orifice to control the jetting direction.

(4) Instead of forming, through the entire inner circumference of the orifice 7b, the inner space 14 extending parallel to the orifice axis X and between the inlet and the outlet of the orifice 7b, this section may be formed with a continuous curve. That is, as

shown in Fig. 5, an inlet-side corner 15 and an outlet-side corner 16 of the orifice peripheries 13 are in the form of smooth convex surfaces instead of defining obtuse angles having edges. This construction can also strengthen the orifice peripheries 13, thereby effectively preventing early damage thereof. In this case, it is preferable that the outlet of the orifice peripheries 13 has a small curvature to prevent the concave section from contacting the high-pressure water.

Claims

1. A descaling nozzle having a nozzle body (7) formed of cemented carbide and defining;

   a liquid passage (7a) having a diameter reducing as it extends downstream with respect to a liquid jetting direction; and
   an orifice (7b) having an inlet communicating with an end of said liquid passage (7a) downstream with respect to the liquid jetting direction and elongated when seen in the liquid jetting direction;
   said orifice (7b) jetting out a high-pressure liquid (W) against a metal surface to remove scales from the metal surface;
   said nozzle body (7) including a concave section (12) formed at a forward end (11) thereof with respect to the liquid jetting direction and having a diameter reducing as it extends downstream with respect to the liquid jetting direction, said forward end (11) having an annular shape integrally surrounding an entire outer circumference of said concave section (12); and
   said orifice (7b) having an outlet opening at a bottom of said concave section (12) around an entire circumference thereof.

2. A descaling nozzle as defined in claim 1, wherein said cemented carbide has a Rockwell hardness (HRA) of 94.0 or higher by A Graduation of Rockwell hardness test stipulated in the Japanese Industrial Standards.

3. A descaling nozzle as defined in claim 1 or 2, wherein said concave section (12) is formed to be out of contact with the high-pressure liquid (W) jetting from said orifice (7b).

4. A descaling nozzle as defined in any one of claims 1 to 3, wherein an inner surface (14) is formed through an inner circumference of said orifice (7b) to extend parallel to an orifice axis and between an inlet and an outlet of said orifice (7b).

5. A descaling nozzle as defined in any one of claims 1 to 4, wherein said concave section (12) and an inner surface of said liquid passage (7a) form an obtuse angle (() across peripheries (13) of said orifice (7b) through the entire circumference of said orifice (7b), whereby said orifice peripheries (13) are thick-walled in the liquid jetting direction through the entire circumference of said orifice (7b).

6. A descaling nozzle as defined in any one of claims 1 to 5, wherein said forward end (11) of said nozzle body (7) with respect to the high-pressure water jetting direction has a flat surface (11a) extending at right angles to the high-pressure water jetting direction and through an entire circumference of the outlet of said orifice (7b).

7. A descaling nozzle as defined in anyone of claims 1 to 6, further comprising a cylindrical passage forming member (2), a filter (3) screwed to one end of the passage forming member (2), and a jet passage forming member (4) screwed to the other end of the passage forming member (2).

8. A descaling nozzle as defined in claim 7, wherein said passage forming member (2) has a straightening passage (2a) with a straightening device (5) mounted therein, and a restricting passage (2b) continuous and coaxial with a downstream end of the straightening passage (2a).

9. A descaling nozzle as defined in any one of claims 2 to 8, wherein said carbide is a carbide hard metal containing carbonized tungsten as a main component thereof.

FIG. 1

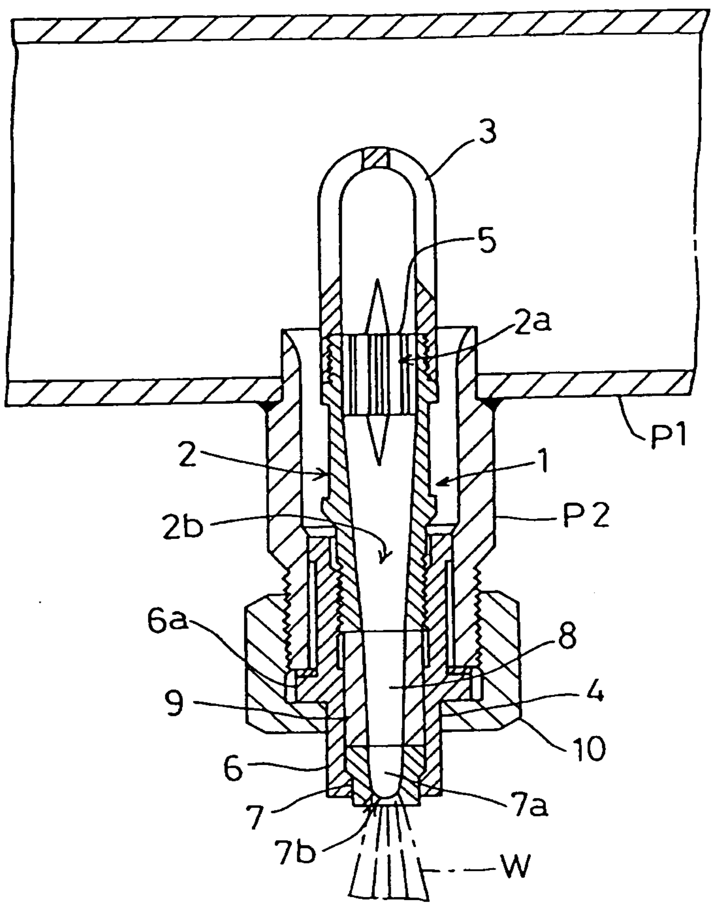


FIG. 2

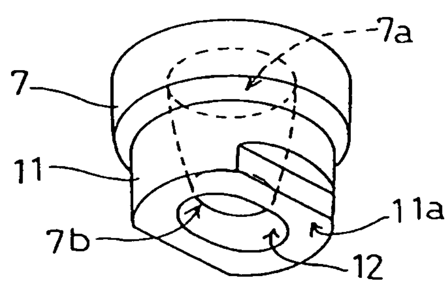


FIG. 3

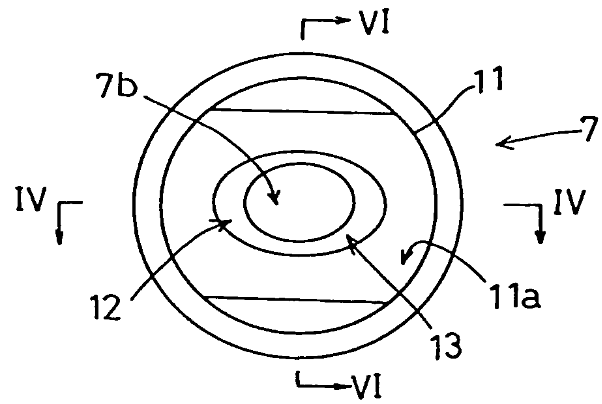


FIG. 4

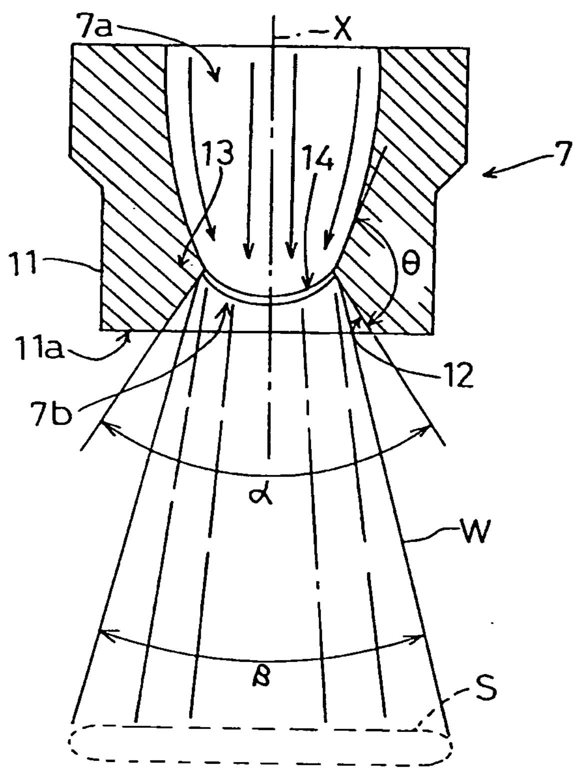


FIG.5

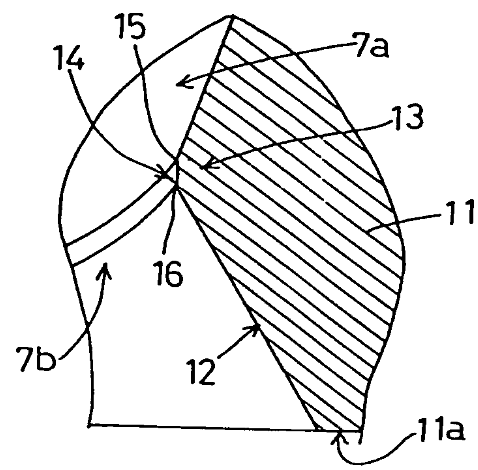


FIG.6

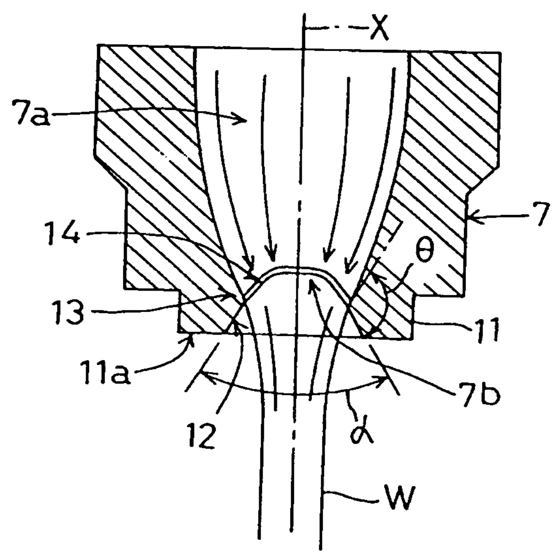


FIG.7

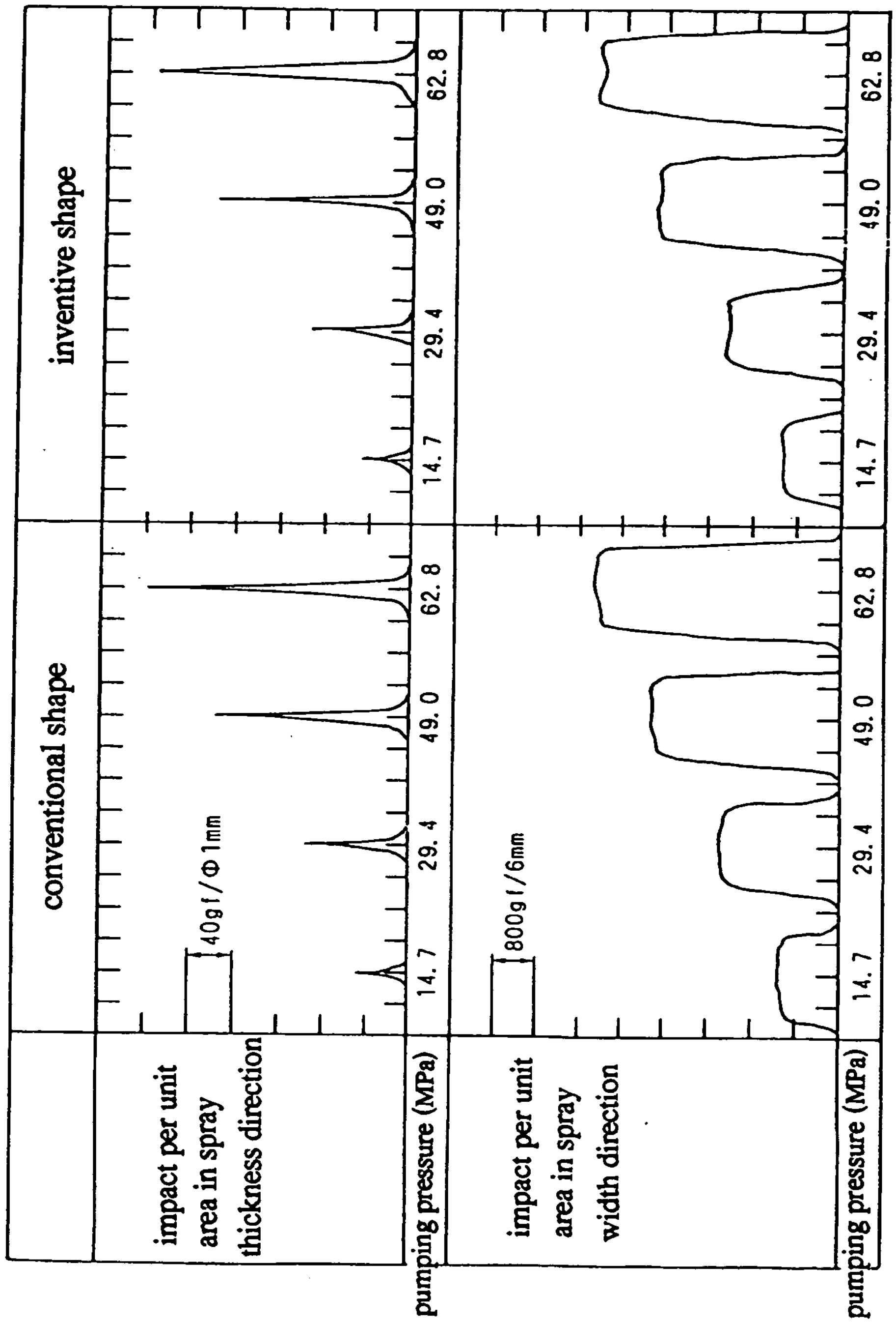

conventional shape
inventive shape
impact per unit area in spray thickness direction
40gf/Φ1mm
pumping pressure (MPa)
14.7
29.4
49.0
62.8
impact per unit area in spray width direction
800gf/6mm
pumping pressure (MPa)
14.7
29.4
49.0
62.8

FIG. 8

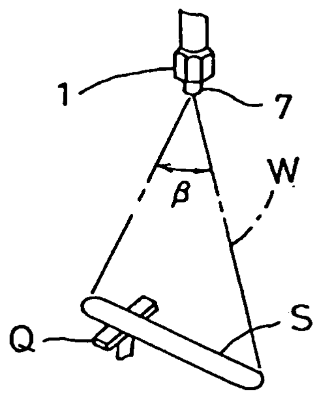
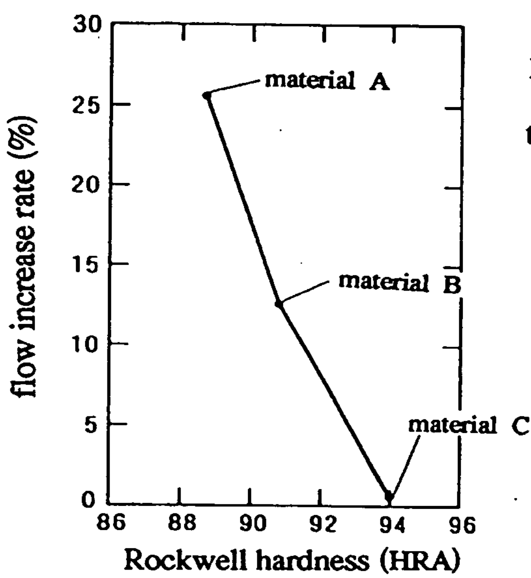


FIG. 9



pumping pressure : 15.7 MPa

testing period : five weeks

FIG. 10

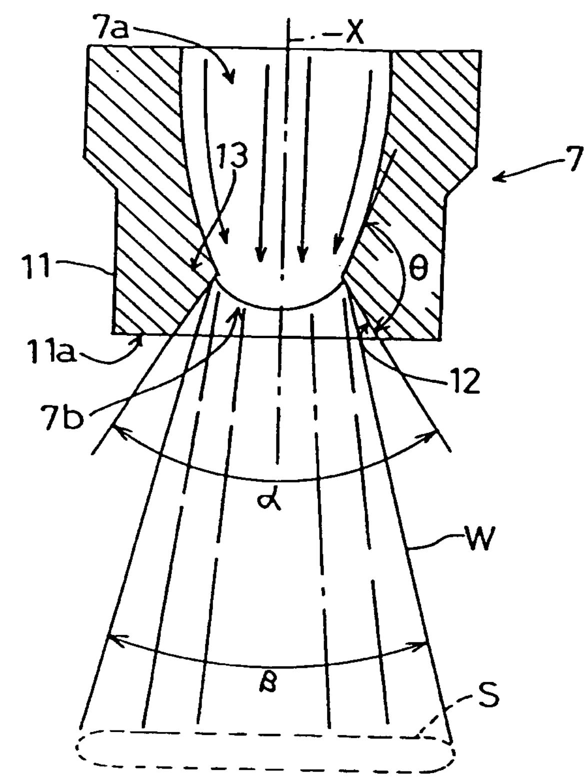


FIG. 11

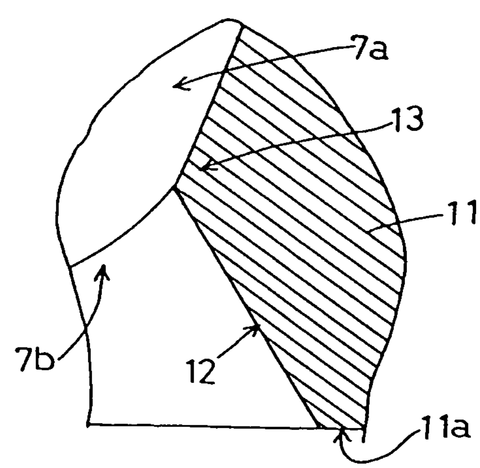


FIG. 12

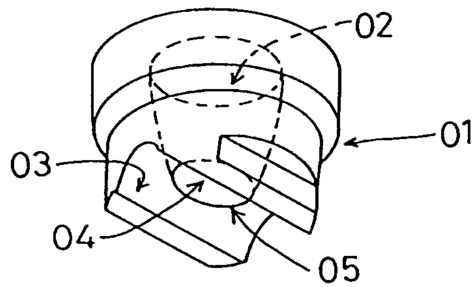


FIG. 13

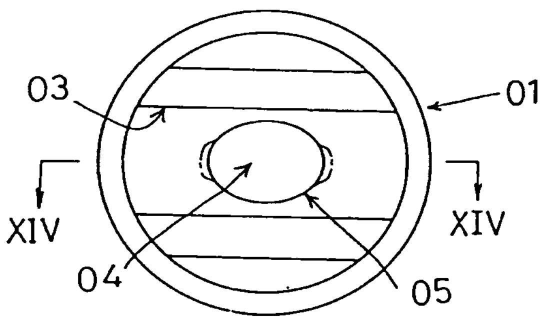
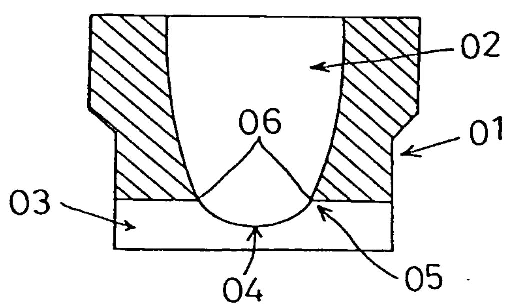


FIG. 14



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP96/02886

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl^6 B05B1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl^6 B05B1/00-1/36

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1926 - 1996
Kokai Jitsuyo Shinan Koho	1971 - 1996
Toroku Jitsuyo Shinan Koho	1994 - 1996

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Microfilm of the specification and drawings annexed to the written application of Japanese Utility Model Application No. 201534/1986 (Laid-open No. 107747/1988)(Narumi China Corp.), July 12, 1988 (12. 07. 88), Page 1, lines 5 to 8; Fig. 1 (Family: none)	1 - 9

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"&" document member of the same patent family

Date of the actual completion of the international search December 18, 1996 (18. 12. 96)	Date of mailing of the international search report December 25, 1996 (25. 12. 96)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)